

Ontario Water Resources Commission

801 Bay Street, Toronto 5, Ontario

A Guide on Estimating **WATER WORKS CONSTRUCTION COSTS** in the Province of Ontario



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Publication No. 2
Design Approvals Branch
Division of Sanitary Engineering

A GUIDE ON ESTIMATING
WATER WORKS CONSTRUCTION COSTS
IN THE PROVINCE OF ONTARIO

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FOREWORD

The Ontario Water Resources Commission through its approval certificates maintains records of water works costs in the Province. By the publication of this guide, it is hoped that the information presented will assist engineers, architects, planners, developers, and municipal officials in the preparation of better preliminary cost estimates for water works projects.

The guide includes the cost of surface water supply and treatment facilities; well supply and treatment facilities; as well as intakes, ground storage reservoirs, booster pumping stations, elevated tanks and standpipes. It does not, however, include water treatment plants utilizing recently developed treatment processes and equipment; supply mains; and water distribution mains. The cost of these works will be presented in succeeding publications.

It has been prepared by the staff of the Design Approvals Branch, Division of Sanitary Engineering, under the supervision of Mr. A. R. Townshend, P.Eng. Mr. A. E. Goodwin, Director, Electronics Computing Branch, Department of Highways, Ontario, authorized the use of its computers for handling the data. The regression curves were determined by Miss June Gardiner, Scientific Programming.

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1.0 INTRODUCTION

It is important that reliable cost estimates be available during the early stages of any proposed water works project. With this information, the municipality or private owner can: (1) determine whether the proposed project can be afforded initially; (2) plan the method of financing to be used; and (3) if necessary, develop an acceptable staged programme. In addition, the engineer or architect might: (1) estimate the most economical method of water supply and treatment without going into detailed design; and (2) judge the validity of competitive bids when tenders are received.

This guide on water works construction costs in Ontario is based on cost estimates taken from the Department of Health and the Ontario Water Resources Commission approval certificates. All project costs have been up-dated to 1965 prices using the Engineering News Record Construction Cost Index for Toronto of 800. The least squares method was used to determine the line of best fit for the available data and statistical procedures were used to determine the standard error of estimate.

The guide gives an example on the use of the graphs and discusses limitations of the cost estimating data. The appendix contains an example of the least squares calculation for Graph No. 1 - Water Intakes. The tables and graphs of the various water works studied follow the appendix.

2.0 DERIVATION OF COST GRAPHS

To derive the cost graphs, it was necessary to gather the required information from the approval certificates, select the construction cost index for conversion purposes, and to prepare tables from which the cost graphs were to be determined.

2.1 SOURCE OF DATA

The sizes and capacities of the facilities studied and their costs were obtained from the applications and approval records of the Department of Health and the Ontario Water Resources Commission.

In most cases, the costs are estimated costs which may have been prepared from one to two years prior to approval.

2.2 SELECTION OF A CONSTRUCTION COST INDEX

An index is a statistical measure designed to show changes in a variable or a group of variables with respect to time, location or other characteristics. By using such an index, a comparison of costs from one year to another for a particular facility can be made.

Three such indexes were considered for use in this study. These were the Engineering News Record Construction Cost Index, the Southam Construction Cost Index and the Weber, Flick & Wilson Waterworks Index.

Following the comparison made, in Publication 1, (A Guide on Estimating Sewage Treatment Plant Construction Costs in the Province of Ontario) and realizing that the American Weber, Flick & Wilson Waterworks Index also closely parallels the E.N.R. Index, it was again decided to use the E.N.R. Construction Cost Index to adjust the cost data to the common base year of 1965.

2.3 FACILITY CAPACITY AND ADJUSTED UNIT COST TABLES

For each type of facility studied, all installations were listed alphabetically by municipality and given a graph number. Next, the approval number or year approved and a description of the facility giving its size or capacity were added to the tables.

All project costs were up-dated to 1965 costs using the E.N.R. Construction Cost Index for Toronto of 800. This was done by multiplying the estimated cost of the project by the ratio of the 1965 E.N.R. Index to the E.N.R. index for the year the facility was approved. Finally, the unit costs were calculated by dividing the adjusted 1965 total cost by the size or capacity of the facility.

3.0 FITTING THE DATA BY THE LEAST SQUARES METHOD

The least squares method as adopted by the United States Public Health Service for its studies on sewage works costs was used to fit the data. It was assumed that the sample distribution would be represented by the equation:

$$\log Y = a + b \log X \quad (1)$$

The line of best fit for each sample distribution was determined by solving the following two normal equations:

$$Na + b \sum X = \sum Y \quad (2)$$

$$a \sum X + b \sum X^2 = \sum XY \quad (3)$$

Where

N = number of observations

$\sum X$ = sum of the logarithms of the facility size or capacity

$\sum X^2$ = sum of the squares of the logarithms of the facility size or capacity

$\sum Y$ = sum of the logarithms of the unit cost

$\sum XY$ = sum of the cross products of logarithm X and logarithm Y

a = the Y intercept

b = the slope of the line

and substituting the values of the constants "a" and "b" into equation (1). This equation then represents the regression or estimating curve for the sample distribution.

The degree of relationship between the two variables used in each sample distribution, was determined from the correlation co-efficient. The co-efficient varies between -1 and +1 and is a good measure of the lineal correlation between the two variables.

As previously mentioned, equation (1) represents the curve of best estimate for the sample distribution. A measure of the scatter about the regression line is supplied by the standard error of estimate of Y on X. This is given by the equation:

$$\sigma_{Y.X} = \sqrt{\frac{\sum (\log Y - \log Y_{est})^2}{N}} \quad (4)$$

If lines are constructed parallel to the regression curve of Y on X at respective vertical distances $\sigma_{Y.X}$ (one standard deviation), the limits which include 68% of the sample distribution are defined.

4.0 USE OF THE COST GRAPHS

The facility size or capacity versus unit cost graphs determined for each treatment process studied together with the tables and results of the least squares calculations follow the appendix.

To illustrate the use of the curves as a guideline in estimating construction costs of water works facilities, it is assumed that the May, 1967 estimated average cost of a 10 MGD complete water filtration plant is required given the corresponding E.N.R. Index for Toronto of 882.35.

From graph No. 3, a 10 MGD filter plant using gravity filters would cost 15.5 cents per gallon or \$1,550,000 in 1965 dollars. Since these curves have been developed using 1965 dollars, it is necessary to up-date the estimated cost using the E.N.R. index. If the May, 1967 E.N.R. index for Toronto is 882.35, the estimated construction cost in 1967 dollars would be $\frac{882.35}{800} \times \$1,550,000 = \$1,710,000$.

The range in which the estimated costs are expected to fall 2/3 of the time may be determined by reading off the upper and lower limits which are 24.5 and 10.0 1965 cents per gallon per day, respectively, for a total estimated cost between \$1,100,000 and \$2,700,000 in 1967 dollars.

5.0 LIMITATIONS OF THE COST ESTIMATING DATA

So that the cost curves may be used most effectively by engineers, architects, planners, developers, and municipal officials, the following limitations should be appreciated:

1. For the surface supply works, that is, Graphs No. 2, No. 3, and No. 4, the estimated costs given are for the complete installation including, where provided, screening, raw water pumps, clear well, and associated building or buildings. The estimated costs do not include, however, the cost of the intake which must be calculated separately from Graph No. 1.
2. It should be assumed for the well supply systems of Graphs No. 5 and No. 9, inclusive, that the cost of drilling and developing the wells are not included in the construction costs which in most cases cover, where provided, the equipment, pumphouse, and associated reservoir.
3. For the complex plants, the estimated costs are not broken down by individual processes such as pumping, pre-treatment, filtration, chlorination, and fluoridation.
4. Similarly, no breakdown in cost is given for such items as materials, mechanical equipment, and labour.
5. In all cases, the estimated costs given by the curves do not include land charges, engineering and contingencies.
6. Again, the costs given are mainly estimated costs which may have been prepared from one to two years before approval was issued. No allowance was made for this factor in converting to 1965 costs using the E.N.R. index.
7. The estimated cost curves cover only limited sizes and capacities of the facilities. Therefore, the curves should be used only within the ranges shown as there is no basis for extrapolation.
8. Where less than about 30 facilities were available for determining the cost graphs, they should be used with particular caution since they have little statistical validity. These graphs in particular will be revised as more data become available.

It is suggested that the most accurate estimates can be made by comparing facilities of equal size or capacity having similar design and construction features. For this reason, the water works studied were numbered in the Tables and were shown on the Graphs. Those who are familiar with comparable installations in the Province of Ontario will, therefore, be able to use this feature to best advantage.

The statistical evaluations of construction costs in this guide for intakes; water supply, and treatment facilities; and booster pumping stations; are based on cost per unit flow. Per capita costs may be approximated from the curves by using the conversion factor of 100 gallons per capita per day.

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APPENDIX
EXAMPLE OF COST ANALYSIS

The following example illustrates the method used to derive the equations and limits which are given in the following graphs and tables.

Data from 24 projects (water intakes) were available. The following data was tabulated from the available information.

$$\begin{aligned}N &= 24 \\ \Sigma X &= 34.5021 \\ \Sigma Y &= 44.6714 \\ \Sigma X^2 &= 50.9561 \\ \Sigma XY &= 65.1316\end{aligned}$$

These values are substituted in the two normal equations.

$$\begin{aligned}Na + b\Sigma X &= \Sigma Y & (1) \\ a\Sigma X + b\Sigma X^2 &= \Sigma XY & (2)\end{aligned}$$

The resulting equations are:

$$\begin{aligned}24a + 34.5021b &= 44.6714 \\ 34.5021a + 50.9561b &= 65.1316\end{aligned}$$

where:

$$\begin{aligned}a &= 0.8936 \\ b &= 0.6731\end{aligned}$$

These constants when substituted into the general equation for the regression curve give the following equation:

$$\log Y = 0.8936 + 0.6731 \log X \quad (3)$$

Since this equation represents the line of best fit for the sample distribution, it represents only the estimated value. In order to establish a cost range, one standard deviation is taken about the estimated value. This will give an upper and lower limit and represents the interval in which the construction costs are expected to fall 68% of the time.

Using equation (3),

$$\begin{aligned}r &= 0.74 \\ \text{Ratio of upper limit} &= 1.4122 \\ \text{Ratio of lower limit} &= 0.7081\end{aligned}$$

Similar calculations are shown in detail in Publication No.1

TABLE 1
CONSTRUCTION COSTS FOR WATER INTAKES
 (Engineering and Contingencies Excluded)
 Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NUMBER	APPROVAL NUMBER	KIND OF PIPE	DIA. OF INTAKE (INCHES)	TOTAL COST IN DOLLARS	LENGTH IN FEET	1965 DOLLARS PER LIN. FT.
AJAX	21	58-B-403	Concrete	36	195,500	2500	104.00
BANCROFT	8	57-B-322	Corr. Metal	15	22,200	800	34.20
BEAVERTON	20	48-B-97	Cast Iron	12	17,300	1200	35.00
BELLE RIVER	1	62-B-453	Corr. Steel	36	73,450	1850	44.00
BURLINGTON	11	63-B-605	Concrete	60	362,700	2400	165.00
DRESDEN	25	57-B-261	Corr. Steel	18	4,700	200	32.40
DUNNVILLE	15	59-B-509	Corr. Metal	48	154,500	1580	121.10
FREEMAN TWP.	10	64-B-143	Corr. Metal	10	5,000	185	27.80
GODERICH	12	61-B-468	Conc. Press.	30	90,500	1250	84.20
HAMILTON	22	1926	Concrete	60	69,000	2953	96.00
HASTINGS	27	61-B-387	Corr. Metal	12	5,000	150	38.60
HUNTSVILLE	4	58-B-319	Conc. Press.	18	20,950	485	57.40
HUNTSVILLE	5	58-B-319	Conc. Press.	24	24,100	485	66.00
KINGSTON	23	41-B-114	Steel	30	39,100	1200	124.00
MEAFORD	13	59-B-154	Concrete	30	91,400	1000	113.00
PICKERING TWP.	14	60-B-57	Concrete	30	127,500	1800	84.40
POINT EDWARD	26	63-B-10	Rein. Conc.	24	41,300	650	69.20
PORT CREDIT	7	60-B-445	Corr. Metal	24	160,000	2800	68.00
SOUTHAMPTON	19	62-B-387	Concrete	24	120,000	900	148.00
TORONTO TWP.	6	62-B-65	Rein. Conc.	66	307,900	3100	110.00
UNION	16	1958	Rein. Conc.	42	103,154	1500	91.00
UNION	17	1958	Coated Steel	42	103,754	1500	93.70
UNION	18	1958	Corr. Metal	54	88,154	1500	77.80
VICTORIA HARBOUR	28	1964	Cement Lined Cast Iron	12	33,400	515	67.00

TABLE 1-A

CONSTRUCTION COSTS FOR WATER INTAKES

VARIABLES

X - Diameter of Intake Pipe (inches)
Y - Construction Costs in 1965
Dollars per linear foot
MODEL - $\log Y = a + b \log X$
EQUATION - $\log Y = 0.8936266 + 0.673128 \log X$
VALID RANGE OF X - 10 to 66 inches
CORRELATION COEFFICIENT - 0.74
STANDARD ERROR OF ESTIMATE - 0.149887
RATIO FOR UPPER LIMIT - 1.4122
RATIO FOR LOWER LIMIT - 0.7081

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	26.11	36.88	52.08
20	41.64	58.80	83.04
40	66.39	93.76	132.41

TABLE 2

CONSTRUCTION COSTS FOR SURFACE
SUPPLY WATER PUMPING STATIONS

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
ATIKOKAN TWP.	Pumphouse Bldg. 54-B-173 1200 GPM Electric Pump - 100 H.P. Electric Motor 1000 GPM Gasoline Standby Pump - 231 H.P. Gas Engine. Chlorination Equip- ment, Controls.		1	2200	105,000	47.8
BALA	Pumphouse Bldg. 50-B-88 2 - Centrifugal Pumps at 145 GPM - Head 160' driven by 15 H.P. Electric Motor (Each) 1 Pump at 600 GPM - 230' Head - Diesel Engine 139 H.P.		2	890	34,000	38.2
CARLETON PLACE	Extension to Pump- 1922 house Bldg. One 600 GPM Pump at 35 H.P. One 600 GPM Fire- pump at 30 H.P.		3	1200	121,000	101
CONISTON (INTERNA- TIONAL NICKEL COMPANY)	Pumphouse Bldg. 58-B-27 and Pumps. Two - 1833 GPM Turbine Pumps. Electric Motors. One Pump is provi- ded with a standby diesel motor. Head 150 feet - 111 H.P. Each		4	3666	79,000	21.6

TABLE 2 (CONT'D)

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
ELLIOT LAKE I.D.	Pumphouse Bldg. 1 Gas Standby - 833 GPM at 60 H.P. 4 Electric Pumps - 2 @ 833 GPM Each @ 100 H.P. Each 1 @ 416 GPM @ 60 H.P. 1 @ 166 GPM @ 25 H.P.	57-B-25	5	3081	58,500	19.0
ESPAÑOLA	Pumphouse Bldg. Pumps, Chlorina- tion. Two Wor- thington 500 GPM Vert. Turbine Pumps 40 H.P. Electric Drives One Worthington 500 GPM Vert. Tur- bine Pump, Rt. Angle 40 H.P. Gasoline Drive.	61-B-270	6	1500	56,000	37.3
FORT FRANCES	Extension to Exist- ing Pumping Station, Telemetering System, Fluoridation and Chlo- rination Equipment, Control System. Two Vert. Turbine Pumps at 2650 G.P.M. at head of 240 feet - Electric Motors 250 H.P. each. Auxiliary Gas Engine 280 H.P.	64-B-382	8	5300	181,500	34.2
FREEMAN TWP. (MACTIER)	Pumphouse Bldg., Pumps, Chlorine Feed Controls, Flow Meter. Two - Electric Pumps at 175 GPM - 15 HP each One - Gas Stand- by Engine 15 HP (Dual Drive)	64-B-143	7	350	29,800	85.2

TABLE 2 (CONT'D)

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
GERALDTON	Pumphouse Bldg. 325 GPM Electric Pump - 40 H.P. 833 GPM Gasoline Standby Pump - 78 H.P.	59-B-592	9	1158	58,700	50.6
GORE BAY	Pumphouse Bldg., Pump, Chlorination. One pump with 100 GPM Capacity Electric Drive and Gas Standby Drive at 160' Head 6.5 H.P. Total 13 H.P.	63-B-86	10	200	13,100	65.5
HEARST	Pumphouse Bldg., Pump. One 750 GPM Cent. Pump, Head 210 ft. 75 H.P. Electric Motor	58-B-250	11	750	11,800	15.8
HUNTSVILLE	Pumphouse Bldg. Pumps. Three Electric Pumps at 15 H.P. each, Total capacity 1232 GPM. One standby at 15 H.P. at 450 GPM	58-B-554	12	1682	45,300	26.9
IROQUOIS	Pumphouse Bldg., Pumps, Metering, and Chlorination. Two 220 GPM Electric Pumps at 15 HP each. One 750 GPM Diesel Pump Standby at 55 HP.	55-B-486	13	1190	36,800	31

TABLE 2 (CONT'D)

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
KENORA (NORMAN AREA)	Pumphouse Bldg., Pumps, Hypochlorinator. One Vert. Turbine 175 GPM - 190' Head Electric Motor 134 HP. One Combination Drive Vert. Turbine Pump 175 GPM at 190' Head - 134 HP. (Combination Drive = 268 HP)	61-B-280	14	350	23,200	66.3
MATHESON	Concrete Pump-house Bldg. 18' x 18'. One 15 HP Oil Engine and Plunger Pump - 185 GPM.	1918	15	185	33,800	182
MORRISBURG	Pumphouse Bldg. and Pumps. Two 800 GPM Vert. Electric Pumps at 245 ft. Head = 2 (75 HP) = 150 HP. One 1200 GPM Electric & Diesel Standby Pump, Head 275 ft. 125 HP.	56-B-358	16	2800	312,000	112
PORT CARLING	Pumphouse Bldg. One Centrifugal Pump 100 GPM 15 HP Electric Motor	48-B-170	17	100	16,200	162

TABLE 2 (CONT'D)

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
RAINY RIVER	Pumphouse Bldg. Pumps, Automatic Chlorinator, Water meter, Automatic Pump Controls. One Vert. Turbine Pump rated at 250 GPM by 15 HP Electric Motor. One Vert. Turbine Pump rated at 833 GPM by 100 H.P. Gasoline Engine.	59-B-4	18	1083	43,800	40.5
RED ROCK I.D.	Pumphouse Bldg., Pumps, Automatic Chlorinator. One Pump at 183 GPM - 15 H.P. One Pump at 250 GPM - 15 H.P. Head of each 150 ft.	47-B-104	19	433	26,300	60.7
SOMBRA TWP.	Pumphouse Bldg., Pumps, Machinery Chlorinator	1931	20	250	18,100	72.5
SOUTH RIVER	Pumping Station, Pump, Chlorinator	1951	21	100	22,600	226
THESSALON	Pumphouse Bldg., Chlorination Controls. Three Vert. Turbine Pumps with Electric Motor drives, each with capacity of 240 GPM against 130 ft. T.D.H. - 12.6 H.P. each or 37.8 H.P. Total. One Vert. Turbine Fire Pump rated at 1850 GPM driven by Diesel Engine 130 TDH - 97 HP.	63-B-501	22	2570	58,000	22.6

TABLE 2 (CONT'D)

MUNICIPALITY	DESCRIPTION	APPROVAL NUMBER	GRAPH NO.	TOTAL CAPACITY (G.P.M.)	TOTAL COST (1965 DOLLARS	1965 DOLLARS PER GALLON PER MINUTE
VICTORIA HARBOUR	Pumphouse Bldg., Chlorinator, Flow Meter, Pumps. Two Vert. Tur- bine Pumps 300 GPM each at 30 H.P. each with one standby Gas Engine.	64-B-427	23	600	27,400	45.7

TABLE 2-A

CONSTRUCTION COSTS FOR
SURFACE SUPPLY WATER PUMPING STATIONS

VARIABLES

X - Gallons per minute
Y - Construction Costs in 1965 dollars per gallon per minute
MODEL - $\log Y = a + b \log X$
EQUATION - $\log Y = 3.0082109 - 0.443393 \log X$
VALID RANGE OF X - 100 to 5300 GPM
CORRELATION COEFFICIENT - .70
STANDARD ERROR OF ESTIMATE - .230070
RATIO FOR UPPER LIMIT - 1.6985
RATIO FOR LOWER LIMIT - .5887

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
100	77.87	132.26	224.64
1000	28.05	47.65	80.93
2000	20.63	35.04	59.52

TABLE 3

CONSTRUCTION COSTS FOR
WATER FILTRATION PLANTS WITH GRAVITY FILTERS

(Land Charges, Intakes & Engineering Costs Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NUMBER	YEAR APPROVED	TORONTO E.N.R. COST INDEX	CAPACITY (M.G.D.)	CENTS PER GALLON PER DAY	1965 CENTS PER GALLON PER DAY
AJAX	1	1958	607	2.08	15.9	21.12
ALEXANDRIA	2	1952	520	0.58	21.9	33.16
AMHERSTBURG	3	1917	167	2.00	3.0	14.40
BEAMSVILLE	4	1953	525	0.43	21.0	32.00
BELLEVILLE	5	1930	170	4.00	5.0	13.60
BRANTFORD EXT.	6	1951	450	2.50	16.0	36.00
BURLINGTON	7	1949	400	1.80	11.0	22.08
BURLINGTON EXT.	8	1961	688	5.00	15.0	17.44
CAMPBELLFORD	9	1963	721	1.25	17.2	19.12
CHELMSFORD	10	1948	395	-	-	
		1961	688	0.25	-	24.16
COBDEN	11	1952	520	0.48	6.9	10.56
CORNWALL	12	1956	558	10.00	10.0	14.32
ESSEX	13	1957	596	8.00	15.9	21.36
GODERICH	14	1961	688	1.50	45.5	52.80
GRIMSBY	15	1922	213	1.08	1.8	6.80
GRIMSBY EXT.	16	1956	558	2.00	10.7	15.36
HAMILTON	17	1931	169	40.00	2.9	13.76
HAMILTON	18	1956	558	40.00	6.7	9.60
HAWKESBURY	19	1953	525	3.00	13.4	20.40
HUNTSVILLE	20	1932	150	0.60	4.6	24.56
KINGSTON	21	1950	400	10.00	7.4	14.80
LAKEFIELD	22	1954	525	0.18	17.6	26.80
LAKEFIELD EXT.	23	1961	688	0.23	23.9	27.76
LINDSAY	24	1917	167	0.30	12.4	59.36
LINDSAY EXT.	25	1957	596	3.10	7.3	9.76

TABLE 3 (CONT'D)

MUNICIPALITY	GRAPH NUMBER	YEAR APPROVED	TORONTO E.N.R. COST INDEX	CAPACITY (M.G.D.)	CENTS PER GALLON PER DAY	1965 CENTS PER GALLON PER DAY
METRO TORONTO (ROSS CLARK)	26	1962	725	100.00	23.0	25.36
NIAGARA FALLS EXT.	27	1958	607	10.00	7.1	9.36
OAKVILLE	28	1955	543	6.00	9.2	13.60
OSHAWA	29	1960	673	5.00	7.0	8.32
OTTAWA (BRITTANIA)	30	1958	607	42.00	10.1	13.28
OTTAWA (LEMIEUX ISLAND)	31	1931	169	42.00	3.1	14.64
PERTH	32	1963	721	2.00	25.7	28.48
PETERBOROUGH	33	1920	225	6.00	5.9	20.96
PETERBOROUGH EXT.	34	1951	450	3.00	9.0	16.00
PICKERING TWP.	35	1960	673	1.25	31.7	37.68
PICTON	36	1952	520	0.81	16.0	24.64
PORT CREDIT	37	1948	213	1.00	10.4	39.20
PORT CREDIT EXT.	38	1950	395	0.50	11.0	22.24
PORT EDWARD	39	1963	721	1.25	24.0	26.56
PORT ELGIN	40	1950	543	0.86	7.2	10.64
PORT HOPE	41	1955	400	1.25	6.8	13.60
RENFREW	42	1958	400	2.00	12.5	24.96
RIVERSIDE-TECUMSEH	43	1925	607	4.00	17.7	23.36
ST. CATHARINES	44	1931	195	10.00	4.0	16.40
ST. THOMAS	45	1924	169	3.00	3.0	14.24
SMITHS FALLS	46	1924	213	2.88	4.5	16.88
SMITHS FALLS EXT.	47	1954	525	2.00	8.8	13.36
SUTTON	48	1956	558	0.40	11.5	16.48
TORONTO TWP.	49	1952	520	2.50	7.1	10.88
TRENTON	50	1952	520	1.00	28.6	44.00
TRENTON EXT.	51	1958	607	1.00	10.2	13.44
WELLAND	52	1925	195	5.70	5.0	20.48
WELLAND EXT.	53	1956	558	3.00	13.3	19.04

TABLE 3-A

CONSTRUCTION COSTS FOR GRAVITY FILTRATION PLANTS

VARIABLES

X - Plant Capacity in million gallons per day

Y - Construction Costs in 1965 cents per gallon per day.

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 1.3240890 - 0.126895 \log X$

VALID RANGE OF X - .18 to 100 MGD

CORRELATION COEFFICIENT - -.38

STANDARD ERROR OF ESTIMATE - .190909

RATIO FOR UPPER LIMIT - 1.5520

RATIO FOR LOWER LIMIT - .6443

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
1	13.59	21.09	32.73
10	10.15	15.75	24.44
100	7.58	11.76	18.25

TABLE 4
 CONSTRUCTION COSTS FOR
 WATER FILTRATION PLANTS WITH PRESSURE FILTERS

(Land Charges, Intakes and Engineering Costs Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NUMBER	YEAR APPROVED	TORONTO E.N.R. COST INDEX	PLANT CAPACITY (M.G.D.)	CENTS PER GALLON PER DAY	1965 CENTS PER GALLON PER DAY
ARNPRIOR	1	1928	180	0.26	10.8	48.00
BEAVERTON	2	1949	400	0.37	8.1	16.16
CAYUGA	3	1956	558	0.24	13.7	19.68
CHATHAM	4	1920	225	1.11	3.4	12.08
COBOURG	5	1933	167	0.19	5.8	27.84
DRESDEN	6	1957	596	0.86	15.0	20.16
DRESDEN EXT.	7	1961	688	1.55	5.4	6.32
EXETER	8	1960	673	0.77	6.1	7.28
FENELON FALLS	9	1960	673	0.25	16.0	19.04
KINCARDINE	10	1959	642	0.24	15.8	19.68
MERRITON	11	1927	185	1.50	4.7	20.32
NAPANEE	12	1933	167	1.38	2.7	12.96
NAPANEE EXT.	13	1960	673	2.50	11.8	14.00
NIAGARA-ON-THE-LAKE	14	1916	119	1.04	1.1	7.44
ORILLIA	15	1955	543	0.33	11.3	16.64
PORT COLBORNE	16	1923	207	1.12	4.6	17.76
PORT COLBORNE EXT.	17	1952	520	1.12	5.1	7.84
POWASSAN	18	1955	543	0.30	10.0	14.72
STRETSVILLE	19	1957	596	0.45	18.0	24.16
THOROLD	20	1927	185	2.00	4.0	17.28
THOROLD EXT.	21	1953	525	0.44	9.9	15.12
TILBURY	22	1931	169	0.90	7.7	36.40
WALLACEBURG	23	1949	370	1.20	4.2	9.04

TABLE 4-A

CONSTRUCTION COSTS FOR PRESSURE FILTRATION PLANTS

VARIABLES

X - Plant Capacity in million gallons per day
Y - Construction Costs in 1965 cents per gallon per day

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 1.430342 - 0.307406 \log X$

VALID RANGE OF X - .19 to 2.50 MGD

CORRELATION COEFFICIENT - -.48

STANDARD ERROR OF ESTIMATE - .197901

RATIO FOR UPPER LIMIT - 1.5773

RATIO FOR LOWER LIMIT - .6340

VALUE FOR PLOTTING

X	- y -		
	Lower Limit	Expected Value	Upper Limit
.2	14.46	22.80	35.96
1	8.81	13.90	21.93
2.	7.12	11.23	17.72

TABLE 5

CONSTRUCTION COSTS FOR DIRECT
PUMPING SINGLE WELL SUPPLY SYSTEMS
WITHOUT TREATMENT

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
ANCASTER TWP.	1	64-B-460	Deep well, pump-house and necessary appurtenances	500	\$63,900.00	\$127.80
ANSON, HINDON & MINDEN TWPS. (Town of Minden)	2	63-B-130	Deep well, pump-house and related appurtenances	150	22,399.50	149.33
ASHFIELD TWP.	3	62-B-175	Pumphouse, pressure tank and related appurtenances	14	2,717.00	194.00
AURORA	4	57-B-125	Pumphouse, telemetering service and all necessary equipment	750	55,817.50	74.42
AURORA	5	62-B-593	Pumphouse, and necessary appurtenances	2500	42,619.00	17.05
AYLMER	6	62-B-251	Pumphouse and necessary appurtenances	200	23,100.00	115.50
BLIND RIVER	7	60-B-660	Heavy caisson well, pumphouse and related appurtenances	100	35,462.00	354.62
BOLTON	8	58-B-428	Pumphouse, manually started standby engine and related appurtenances	350	67,320.00	192.34
BRADFORD	9	62-B-169	Pumphouse, standby engine, automatic telemetering system and necessary controls	400	29,700.00	74.25

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
BRAMPTON (Agrab Well)	10	63-B-337	Pumphouse and necessary appurtenances	700	\$52,614.30	\$ 75.16
BRUSSELS	11	64-B-11	Pumphouse and related controls	200	7,808.58	39.04
BURLINGTON (Nelson Heights)	12	63-B-703	Pumphouse, 1000 gal. pressure tank, and necessary controls	20	4,360.00	218.00
CANNINGTON	13	61-B-75	Pumphouse, and related appurtenances	50	11,817.00	236.34
CAPREOL	14	57-B-232	Pumphouse and necessary appurtenances	200	21,407.02	107.04
CHINGUACOUSY TWP.	15	59-B-283	Pumphouse, pump controls and necessary appurtenances	700	71,250.00	101.79
CLARKE TWP.	16	65-B-15	Drilled well, pumphouse, 75 gpm pump, electrical equipment and necessary appurtenances	150	170,100.00	1134.00
CLIFFORD	17	64-B-141	Deepwell, pumphouse, flow meter and necessary appurtenances	150	9,578.61	63.86
COOKSTOWN	18	62-B-140	Pumphouse, and related controls	42	28,930.00	688.81
CUMBERLAND TWP.	19	62-B-10	Deepwell, pumphouse and related appurtenances	50	5,610.00	112.20
DURHAM	20	64-B-135	Deepwell, pumphouse, flow meter and related appurtenances	500	17,402.10	34.80
EASTHOPE N. TWP.	21	57-B-456	Pumphouse, 100 gal. pressure tank and related equipment	10	672.50	67.25

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
ELMVALE	22	60-B-337	Pumphouse and necessary appurtenances	350	\$39,686.50	\$113.39
FONTHILL	23	65-B-282	Pumphouse, automatic controls, and related appurtenances	450	26,800.00	595.55
GRAVENHURST	24	59-B-42	Pumphouse and related appurtenances	700	40,125.00	57.32
GUELPH TWP.	25	57-B-408	Pumphouse and related equipment	170	16,140.00	94.94
GUELPH TWP.	26	58-B-481	Pumphouse, manual standby engine, and related equipment	350	67,320.00	192.34
HAGERSVILLE	27	58-B-603	Pumphouse and related equipment	200	5,676.00	28.38
HANOVER	28	61-B-161	Pumphouse and related appurtenances	700	39,780.00	56.83
HARRISTON	29	61-B-162	Pumphouse, metering, pressure controls and necessary appurtenances	300	11,893.05	39.64
HAY TWP.	30	60-B-45	Pumphouse 120 gallon pressure tank, and related equipment	16.7	1,195.95	71.61
HOWICK TWP.	31	63-B-495	Pumphouse, two-450 gallon pressure tanks, and related equipment	50	5,248.35	104.97
KEMPTVILLE	32	61-B-95	Pumphouse and necessary appurtenances	150	9,945.00	66.30
KING TWP. (King City #2)	33	57-B-546	Pumphouse and related appurtenances	100	23,537.50	235.38

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
KING TWP. (Nobleton)	34	60-B-503	Pumphouse and related appurtenances	300	\$36,630.58	\$122.10
KING TWP. (King City #3)	35	63-B-312	Pumphouse, gasoline standby engine, and related appurtenances	300	67,362.00	224.54
LANARK	36	60-B-56	Deepwell, pumphouse, pressure tank, and related equipment	41.6	17,850.00	429.09
LONDON (Fanshawe Field)	37	64-B-358	Well #6, deepwell, pumphouse, flow meter, and related appurtenances	700	40,470.00	57.81
LONDON (White Oaks)	38	61-B-221	Pumphouse and necessary equipment (water treated at White Oaks Iron Removal Plant)	700	53,001.00	75.72
LUCKNOW	39	58-B-707	Pumphouse and necessary equipment	167	12,521.52	74.98
MARATHON I.D. (Well #3)	40	63-B-508	Pumphouse and related appurtenances	350	35,152.50	100.44
MARKHAM TWP.	41	57-B-457	Pumphouse and related appurtenances	350	133,827.50	382.36
McDOUGALL TWP. (Nobel Area)	42	63-B-683	Pumphouse, gasoline standby engine, pressure tank and related appurtenances	100	14,170.00	141.70
MERRICKVILLE	43	61-B-134	Deepwell, pumphouse, and related equipment	150	10,710.00	71.40
MILTON	44	57-B-558	Pumphouse, automatic gasoline standby engine and related appurtenances	400	46,402.50	116.01

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
MUSKOKA TWP.	45	57-B-569	Pumphouse, pressure tank and related appurtenances	83.3	\$ 4,707.50	\$ 56.51
NEELON & GARSON TWP.	46	58-B-291	Pumphouse, standby engine, and related appurtenances	500	49,830.00	99.66
NEELON & GARSON TWP.	47	62-B-517	Pumphouse, standby gasoline engine, closed circuit control system	500	46,640.00	93.28
NEPEAN TWP.	48	57-B-199	Deepwell, pump-house, pressure tank and related appurtenances	33.4	73,975.00	2214.82
NEW HAMBURG	49	63-B-207	Deepwell, pump-house, and necessary appurtenances	208	21,450.00	103.13
NICHOL TWP.	50	64-B-389	Pumphouse, 325 gallon pressure tank and necessary appurtenances	22	3,727.50	169.43
OPS TWP. (Springdale Gardens)	51	62-B-562	Pumphouse, gasoline standby engine, and related appurtenances	100	10,978.12	109.78
ORANGEVILLE	52	61-B-494	Pumphouse and related appurtenances	100	16,380.00	163.80
OSGOODE TWP.	53	60-B-371	Pumphouse and related appurtenances	250	53,550.00	214.20
PENETANG	54	61-B-266	Pumphouse and necessary appurtenances	500	33,345.00	66.69

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
PLAYFAIR TWP.	55	61-B-254	Pumphouse and necessary appurtenances	60	\$12,285.00	\$204.75
PRESTON	56	59-B-442	Pumphouse and related appurtenances	200	25,000.00	125.00
PUSLINCH TWP. (Papan1)	57	60-B-135	Pumphouse, 2000 gal. pressure tank, and related appurtenances	200	23,800.00	119.00
PUSLINCH TWP. (Guelph Dev.)	58	59-B-588	Pumphouse, diesel standby engine and necessary appurtenances	180	16,250.00	90.28
RATTER & DUNNET TWP.	59	60-B-633	Pumphouse and related controls	100	12,138.00	121.38
RICHMOND HILL (Well #5)	60	63-B-381	Pumphouse, gasoline standby engine, and necessary appurtenances	600	48,787.31	81.31
RIDGETOWN	61	59-B-408	Pumphouse and necessary appurtenances	150	37,562.50	250.42
SHEDDEN TWP.	62	57-B-166	Pumphouse, standby engine and necessary appurtenances	50	22,865.00	457.30
STANLEY TWP.	63	60-B-323	Pumphouse, 200 gal. pressure tank, and related appurtenances	17	1,309.00	77.00
STANLEY TWP.	64	64-B-602	Pumphouse and necessary appurtenances	36	2,470.80	68.63
STANLEY TWP. (Varna)	65	63-B-265	Pumphouse, 325 gal. pressure tank and necessary appurtenances	20	5,450.00	272.50

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
STAYNER	66	59-B-391	Pumphouse, flow meter and related equipment	200	\$34,196.25	\$170.98
TIVERTON	67	62-B-634	Deepwell, pump-house and related appurtenances	250	4,400.00	17.60
TUCKERSMITH TWP.	68	63-B-202	Pumphouse, 500 gal. pressure tank, and related appurtenances	300	3,869.50	12.90
UXBRIDGE	69	64-B-130	Gravel wall well, pumphouse and related appurtenances	450	62,898.90	139.78
VAUGHAN TWP.	70	60-B-474	Pumphouse and related appurtenances	240	17,850.00	74.38
WALKERTON	71	63-B-319	Pumphouse, flow meter, telemetering system and related appurtenances	167	18,530.00	110.96
WATERLOO	72	58-B-601	Pumphouse and related appurtenances	700	60,720.00	86.74
WATERLOO TWP.	73	60-B-102	Deepwell, pumphouse and related appurtenances	60	3,570.00	59.50
WATERLOO TWP.	74	61-B-348	Pumphouse, 1000 gal. pressure tank and related appurtenances	148	6,084.00	41.11
WATERLOO TWP.	75	59-B-754	Pumphouse, drilled well and related appurtenances	100	7,785.00	77.85
WAWANOSH W. TWP.	76	61-B-373	Pumphouse, 530 gal. pressure tank, and related appurtenances	11	1,148.94	104.45

TABLE 5 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLONS PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
WHITBY TWP. (Brooklin)	77	60-B-634	Pumphouse and related appurtenances	150	\$27,965.00	\$186.43
WHITBY TWP. (Meadowbrook)	78	60-B-63	Pumphouse and related appurtenances	25	6,604.50	264.18
WOODSTOCK (Well #5)	79	62-B-275	Pumphouse and related controls	1000	101,200.00	101.20
ZURICH	80	62-B-596	Pumphouse and necessary appurtenances	58.4	13,200.00	226.03

TABLE 5-A

CONSTRUCTION COSTS FOR
DIRECT PUMPING SINGLE WELL SUPPLY SYSTEMS WITHOUT TREATMENT

VARIABLES

X - Capacity in gallons per minute

Y - Construction costs in 1965 dollars per gallon per minute

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 2.6136463 - 0.250427 \log X$

VALID RANGE OF X - 10 to 2500 GPM

CORRELATION COEFFICIENT - -.35

STANDARD ERROR OF ESTIMATE - .350819

RATIO FOR UPPER LIMIT - 2.2429

RATIO FOR LOWER LIMIT - .4458

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	102.89	230.79	517.64
100	57.80	129.66	290.81
1000	32.47	72.84	163.37

TABLE 6
CONSTRUCTION COSTS FOR WELL
SUPPLY SYSTEMS WITH CHEMICAL TREATMENT ONLY

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
ACTON	1	57-B-350	Pumphouse, chlorinator and necessary appurtenances	200	\$40,013.75	\$200.07
ALLISTON	2	61-B-435	Pumphouse, chlorinator, standby gasoline engine and related controls	550	63,180.00	114.87
BARRIE	3	59-B-567	Gravel wall well, pumphouse, chlorinator, and related appurtenances	700	50,625.00	72.32
CUMBERLAND TWP.	4	61-B-19	Pumphouse, hypochlorinator and related appurtenances	50	8,002.66	160.05
FALCONBRIDGE TWP.	5	62-B-48	Pumphouse, gas chlorinator and related appurtenances	2000	84,045.50	42.02
FENELON TWP.	6	62-B-511	Pumphouse, hypochlorinator pressure tank, and related appurtenances	6.67	5,940.00	890.55
FOREST	7	65-B-62	Pumphouse, chlorinator, and related appurtenances	200	8,710.00	43.55
GOULBOURN TWP.	8	63-B-284	Pumphouse, standby power, hypochlorinator, and related appurtenances	300	7,630.00	25.43

TABLE 6 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
GUELPH	9	63-B-133	Conversion of existing system; reservoir, service pumps, Calgon treatment, chlorination and related appurtenances	300	\$18,530.00	\$ 61.77
GUELPH	10	60-B-119	Pumphouse, 1000 gal. pressure tank, chlorinator, and related appurtenances	500	21,182.00	42.36
GUELPH	11	59-B-635	Pumphouse, 1000 gal. pressure tank, chlorinator and related appurtenances	300	21,500.00	71.67
INNISFIL TWP.	12	65-B-239	Pumphouse, 2000 gal. pressure tank, chlorinator and related appurtenances	29	5,700.00	196.55
NEWMARKET	13	57-B-348	Pumphouse, standby power, chlorination for iron and necessary appurtenances	350	60,928.50	174.08
WATERFORD	14	64-B-643	Pumphouse, chlorinator, flow meter and related appurtenances	450	47,392.50	105.32
WELLINGTON	15	62-B-427	Pumphouse, standby power, chlorinator, and related appurtenances	105	21,460.00	204.29
VAUGHAN TWP.	16	61-B-204	Deepwell, pumphouse, 1000 gal. pressure tank, chlorinator and related appurtenances	40	3,978.00	99.45

TABLE 6-A

CONSTRUCTION COSTS FOR WELL
SUPPLY SYSTEMS WITH CHEMICAL TREATMENT ONLY

VARIABLES

X - Capacity in gallons per minute
Y - Construction costs in dollars per gallon per minute
MODEL - $\log Y = a + b \log X$
EQUATION - $\log Y = 3.0160534 - 0.441370 \log X$

VALID RANGE OF X - 6.67 to 2000 GPM

CORRELATION COEFFICIENT - -.72

STANDARD ERROR OF ESTIMATE - .268636

RATIO FOR UPPER LIMIT - 1.8562

RATIO FOR LOWER LIMIT - .5387

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	202.31	375.56	697.11
100	73.25	135.93	252.31
1000	26.50	49.20	91.33

TABLE 7

CONSTRUCTION COSTS FOR WELL SUPPLY SYSTEMS
WITH TREATMENT-AERATION AND SETTLING

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
DEREHAM TWP	1	64-B-136	Pumphouse, aeration tank, iron removal, 300 gal. pressure tank, and related appurtenances	16.7	\$ 4,525.54	\$270.10
INGERSOLL	2	64-B-289	Deepwell, pumphouse, 500 forced draft aerator, reservoir, service pump and necessary appurtenances		29,287.50	58.58
LONDON	3	63-B-615	4 Radial wells, 2 aerators, reservoir, 2-2100 USgpm service pumps, and related appurtenances	4166.7	343,350.00	82.40
ST. THOMAS	4	64-B-529	Gravel wall well, pumphouse, aeration, detention tank, 500 gpm booster pump and related appurtenances	500	69,225.00	138.45
STRATFORD	5	64-B-648	Pumphouse, 200,000 gal. reservoir, aeration and necessary appurtenances	600	47,925.00	79.88
TILLSONBURG	6	63-B-588	2 Wells, pumphouses, 500 reservoir, chlorination, flow meter, splash aerator 2 - 250 gpm service pumps and related appurtenances		76,272.75	152.55

TABLE 7 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
VAUGHAN TWP.	7	60-B-178	Gravel wall well, pumphouse, electric pump with standby, aeration over baffles to storage, service pumps and related equipment	150	\$18,564.00	\$123.76

TABLE 7-A

CONSTRUCTION COSTS FOR WELL SUPPLY
SYSTEMS WITH TREATMENT AERATION AND SETTLING INCLUDED

VARIABLES

X - Capacity in gallons per minute
Y - Construction costs in 1965 dollars per gallon per minute
MODEL - $\log Y = a + b \log X + c(\log X)^2$
EQUATION - $\log Y = 3.0638528 - 0.621517 \log X + 0.084024 (\log X)^2$

VALID RANGE OF X - 16.7 to 4166.7 GPM

CORRELATION COEFFICIENT - .78

STANDARD ERROR OF ESTIMATE - .169596

RATIO FOR UPPER LIMIT - 1.4777

RATIO FOR LOWER LIMIT - .6767

VALUE FOR PLOTTING -

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
40	130.08	192.22	284.04
100	92.75	137.06	202.53
400	70.13	103.64	153.15
1000	61.08	90.26	133.38
2000	57.32	84.70	125.16

TABLE 8
**CONSTRUCTION COSTS FOR WELL SUPPLY SYSTEMS
 WITH TREATMENT AND FILTRATION**

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
BRAMPTON	1	58-B-225	Pumphouse, iron removal, pressure aeration and filtration and related appurtenances	700	\$65,934.00	\$ 94.19
GLOUCESTER TWP.	2	61-B-54	2 Wells, 750 gal. pressure tank, Cascade Aerator, Infilio "Accelerator" alum & coagulant feeds, 2 pressure sand filters (50 USgpm each), 25,000 gal. reservoir, surge tank & related appurtenances	41.7	52,650.00	1262.59
LANCASTER TWP.	3	65-B-235	2 - 70 gpm pumps run alternately, pumphouse, 10,000 gallon reservoir, 2 - 200 gpm service pumps, softening and related appurtenances	70	14,000.00	200.00
LONDON	4	59-B-204	Pumphouses, aeration, chlorination, filtration for sulphur and ammonia removal, and related appurtenances	2800	219,562.50	78.42
RICHMOND	5	59-B-547	Pumphouse, chlorination, filtration, 500,000 gallon reservoir and necessary appurtenances	350	48,750.00	139.29

TABLE 8 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NUMBER	DESCRIPTION	CAPACITY GALLON PER MINUTE	TOTAL COST (1965 DOLLARS)	1965 DOLLARS PER GALLON PER MINUTE
VAUGHAN TWP. (CONCORD)	6	63-B-627	Deepwell, pump-house, iron treatment, closed vessel aerator, pressure filters, hypochlorinator, reservoir and necessary appurtenances	350	\$161,211.00	\$460.60
VAUGHAN TWP. (EDGERLY WELL)	7	62-B-131	Pumphouse, filtration, iron removal and related appurtenances	250	104,692.50	418.77
VAUGHAN TWP.	8	59-B-675 350	2 Wells, pumphouses, 400 gpm iron treatment filtration, reservoir, 200 gpm standby and related appurtenances	227,500.00	568.75	

TABLE 8-A

CONSTRUCTION COSTS FOR WELL SUPPLY SYSTEMS
WITH TREATMENT AND FILTRATION

VARIABLES

X - Capacity in gallons per minute

Y - Construction costs in 1965 dollars per gallons per minute

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 3.7151190 - 0.517297 \log X$

VALID RANGE OF X - 41.7 to 2800 GPM

CORRELATION COEFFICIENT - -.70

STANDARD ERROR OF ESTIMATES - .326853

RATIO FOR UPPER LIMIT - 2.1225

RATIO FOR LOWER LIMIT - .4711

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
100	225.76	479.21	1,017.12
400	110.20	233.93	496.52
1000	68.60	145.62	309.08

TABLE 9

CONSTRUCTION COSTS FOR DOUBLE
PUMPING WELL SUPPLY SYSTEMS WITH AND WITHOUT TREATMENT

(Engineering and Contingencies excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	APPROVAL NO.	DESCRIPTION	TOTAL CAPACITY (G.P.M.)	1965 TOTAL COST	1965 DOLLARS PER GAL. PER MIN.
AMELIASBURG TWP. (Parrott Sub.)	1	64-B-177	Pumphouse, 2 wells, 1,000 gal. pressure tank, flow meter & related appurtenances	53	\$ 7,401.75	\$ 139.66
ALFRED	2	58-B-339	Well pumphouse, 500 gpm standby chlorinator, reservoir, 2 service pumps and related appurtenances	500	80,652.00	161.30
BARRIE (Perry Street)	3	59-B-819	Pumphouse, chlorinator, 1000 reservoir, service pump and related appurtenances.	1000	75,000.00	75.00
BRANTFORD TWP. (Tutela Heights)	4	61-B-485	Pumphouse, chlorinator, 100,000 gal. reservoir, high lift station and necessary appurtenances	60	61,425.00	1,023.75
BURWASH INDUSTRIAL FARM	5	64-B-541	Pumphouse, hypochlorinator, 250,000 gal. reservoir, 2 service pumps (260 gpm and 100 gpm), diesel standby (840 gpm) and related appurtenances	250	163,397.63	653.59
CALEDON EAST	6	60-B-641	Pumphouse, 300 gpm gas. standby, 30,000 gal. steel reservoir, 300 gpm service pumps and related appurtenances	150	41,650.00	277.67

TABLE 9 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NO.	DESCRIPTION	TOTAL CAPACITY (G.P.M.)	1965 TOTAL COST	1965 DOLLARS PER GAL. PER MIN.
CUMBERLAND TWP. (Parks & Gardens Subdivision)	7	63-B-51	2 wells, 200,000 gal. reservoir, pumphouse, 540 USgpm service pump, 2080 US gal. standby at reservoir & related appurtenances	250	\$100,280.00	\$ 401.12
DOVER TWP.	7a	65-B-441	Pumphouse, 42 gal. pressure tank, 2,000 gal. reservoir, 13.3 gpm service pump, 210 gal. pressure tank and related appurtenances	8	2,790.00	348.75
ERNESTOWN TWP. (Harwood Sub.)	7b	64-B-39	Pumphouse, chlorinator, 5,800 gal. reservoir, 60 gpm service pump, and related appurtenances	20	8,748.98	437.45
FRANKFORD	8	57-B-480	Pumphouse, standby power, reservoir, service pumps and related appurtenances	150	43,040.00	286.93
GLOUCESTER TWP.	9	59-B-205	Pumphouse, 100,000 gal. 76 reservoir, two 125 US gpm service pumps and related controls	76	20,625.00	271.38
GWILLIMBURY TWP. E. (Sharon)	10	59-B-250	Pumphouse, reservoir, service pumps and related appurtenances	20	18,125.00	906.25
GWILLIMBURY N. TWP. (Glenwood, Pine and Elmhurst)	11	63-B-218	Pumphouse, reservoir, high lift pumps, pressure tanks and related appurtenances	75	8,559.77	114.13
HARWICH TWP.	11a	65-B-553	Pumphouse, 16,800 gal. reservoir, two 100 gpm service pumps and related appurtenances	6	5,000.00	833.33

TABLE 9 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NO.	DESCRIPTION	TOTAL CAPACITY (G.P.M.)	1965 TOTAL COST	1965 DOLLARS PER GAL. PER MIN.
HAVELOCK	12	65-B-489	Pumphouse, flow meter, 100 reservoir, booster pump, chlorinator and necessary appurtenances		\$ 8,800.00	88.00
INNISFIL TWP.		60-B-22	Pumphouse, 1,000 gal. catch basin, 103,000 gal. reservoir, 300 US gpm service pump and necessary appurtenances	20.8	26,715.50	1,284.40
KINLOSS TWP.	12a	61-B-450	Pumphouse, 5,000 gal. reservoir, 16.8 US gpm service pump, 120 gal. pressure tank and appurtenances	5	3,872.70	774.54
KITCHENER	13	61-B-167	Two deep wells, pump-houses, reservoir, one 695 gpm service pump, two 1390 gpm service pumps and necessary appurtenances	695	359,775.00	517.66
MONAGHAN N. TWP.	14	58-B-48	Pumphouse, surge tank, 45.8 reservoir, 200 USgpm service pump and necessary appurtenances	45.8	20,988.00	458.25
MARCH TWP.	15	64-B-144	2 wells, pumphouses, 200 250,000 gal.reservoir, 2 service pumps,chlorinator, standby power and related appurtenances	200	53,250.00	266.25
MURRAY TWP. (B.A. 011)	16	63-B-328	Pumphouse, 25,000 gal. 15 reservoir, high lift pump and related appurtenances	15	14,392.90	959.53
NEPEAN TWP.	17	58-B-184	Pumphouse, reservoir,3 250 service pumps, gas stand-by and necessary appurtenances	250	58,027.20	232.11

TABLE 9 (CONT'D)

MUNICIPALITY	GRAPH NO.	APPROVAL NO.	DESCRIPTION	TOTAL CAPACITY (G.P.M.)	1965 TOTAL COST	1965 DOLLARS PER GAL. PER MIN.
NEPEAN TWP. (Lynwood)	18	58-B-551	Pumphouse, 250,000 US gal.reservoir, 3 service pumps, gas standby and related appurtenances	333.3	\$99,000.00	\$ 297.00
NEPEAN TWP.	19	58-B-599	Pumphouse, 150,000 US gal.reservoir, 3 service pumps, gas standby and related appurtenances	333.3	92,400.00	277.20
PLAYFAIR TWP.		61-B-33	2 deep wells, pumphouses 30 20,000 gal. reservoir, service pumps, chlorination, pressure tank, and necessary appurtenances	30	59,760.00	1,992.00
TAY TWP.		58-B-34	Pumphouse, 50,000 gal. reservoir, and related appurtenances	7	12,540.00	1,791.43
VANKLEEK HILL	20	65-B-442	2 wells, pumphouse, standby power, gas chlorinator and related appurtenances	110	37,800.00	343.64
WATERLOO TWP.	21	62-B-621	Deep well, pumphouse, reservoir, 2 pressure tanks and related appurtenances	25	10,477.28	419.09

TABLE 9-A

CONSTRUCTION COSTS FOR DOUBLE PUMPING WELL
SUPPLY SYSTEMS WITH AND WITHOUT TREATMENT

VARIABLES

X - Capacity in gallons per minute

Y - Construction Costs in 1965 dollars per gallon per minute

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 3.2198477 - 0.335884 \log X$

VALID RANGE OF X - 5 to 1000 GPM

CORRELATION COEFFICIENT - -.59

STANDARD ERROR OF ESTIMATE - .303527

RATIO FOR UPPER LIMIT - 2.0115

RATIO FOR LOWER LIMIT - .4971

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	380.57	765.53	1,539.86
100	175.61	353.25	710.57
1000	81.03	163.00	327.89

TABLE 10

CONSTRUCTION COSTS FOR
GROUND WATER STORAGE RESERVOIRS

(Engineering and Contingencies Excluded)

Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR APPROVED	TORONTO E.N.R. INDEX	CAPACITY (M.G.)	COST PER GALLON (CENTS)	1965 CENTS PER GALLON
ACTON	1	1961	688	1.0	9.6	10.7
DUNDAS	2	1958	607	1.0	7.4	9.3
GALT	3	1963	732	2.5	7.2	7.5
GUELPH	4	1962	725	3.0	8.3	8.8
KITCHENER	5	1958	607	5.0	5.3	6.7
PRESTON	6	1958	607	1.5	6.9	8.7
TORONTO	7	1962	725	30.0	6.5	6.9
VINELAND	8	1964	750	0.50	14.4	14.7
WATERDOWN	9	1961	688	0.36	16.7	18.5

TABLE 10-A

CONSTRUCTION COSTS FOR
GROUND STORAGE RESERVOIRS

VARIABLES

X - Capacity in millions of gallons

Y - Construction Costs in 1965 cents per gallon

MODEL - $\log Y = a + b \log X + C(\log X)^2$

EQUATION - $\log Y = 1.0236691 - 0.411290 \log X + 0.196849 (\log X)^2$

VALID RANGE OF X - .36 to 30 million gallons

CORRELATION COEFFICIENT - .97

STANDARD ERROR OF ESTIMATE - .039706

RATIO FOR UPPER LIMIT - 1. 0957

RATIO FOR LOWER LIMIT - .9126

VALUES FOR PLOTTING

X	- Y -		
	Lower Limit	Expected value	Upper Limit
.4	15.09	16.54	18.12
1	9.64	10.56	11.57
2	7.55	8.27	9.06
4	6.42	7.04	7.71
10	5.89	6.45	7.07

TABLE 11
**CONSTRUCTION COSTS FOR
 WATER BOOSTER PUMPING STATIONS**

(Engineering and Contingencies Excluded)
 Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	DATE OF APPROVAL	DESCRIPTION	HORSE POWER	TOTAL COST IN DOLLARS (1965)	1965 DOLLARS PER HORSE POWER
ALDERWOOD MANOR WASHINGTON, USA	1	1962	4 - 5 MGD pumps 450 H.P. each	1800	\$111,000	\$103.50
BRANTFORD	2	63-B-368	2 Pumps and 1 Diesel standby	285	56,400	198.00
BURLINGTON	3	60-B-274	1 Pump 4500 GPM	58.5	20,400	350.00
DENVER, USA	4	1961	-	6000	570,000	95.00
DENVER, USA	5	1961	-	3000	325,000	109.00
ELLIOT LAKE	6	57-B-25	1 Gas standby 4 Elect. pumps	347	60,000	173.00
FREEMAN TWP	7	64-B-143	2 Pumps; 1 Standby	60	35,000	584.00
GORE BAY	8	63-B-86	1 Pump & 1 Standby CHL; Meter; and Automatic controls	34	17,400	514.00
HUNTSVILLE	9	58-B-554	3 Elect. pumps @ 15 H.P. each 1 Standby @ 20 H.P.	65	34,400	457.00
KINGSTON	10	64-B-206	2 - 100 H.P. Elect. motors 1 - 100 H.P. Diesel motors	400	105,500	264.00
KINGSTON TWP	11	61-B-592	1 Elect. Pump 50 H.P. 100 1 Standby 50 H.P.		13,400	134.00
LONDON	12	64-B-152	-	6300	772,000	122.00
MASSEY	13	61-B-42	2 Pumps; Generator; CHL; etc.	60	42,700	712.00
NIAGARA TWP	14	64-B-115	3 Pumps & equipment 37.7 H.P. + 37.7 H.P. + 9.7 H.P.	85.1	25,800	303.00

TABLE 11 (CONT'D)

MUNICIPALITY	GRAPH NO.	DATE OF APPROVAL	DESCRIPTION	HORSE POWER	TOTAL COST IN DOLLARS (1965)	1965 DOLLARS PER HORSE POWER
NORTH BAY	15	61-B-163	1 Pump; Telemetering service	11.0	\$ 6,040	\$548.00
OAKVILLE	16	60-B-278	1 Pump	50	30,000	600.00
OWEN SOUND	17	60-B-617	Fire pump + 2 Service pumps. Aut. control equipment	197.1	40,500	206.00
PETROLIA	18	61-B-574	2 Elect. pumps @ 50 H.P. each 1 Generator (Diesel) 67 H.P.	167	60,000	360.00
PORT ARTHUR	19	63-B-358	2 Elect. motors; 40 H.P. & 60 H.P. 1 Diesel 353 H.P.	453	46,300	102.00
PORT HOPE	20	60-B-574	3 Elect. H.P. $7\frac{1}{2}$; $7\frac{1}{2}$; 25. 1 Diesel 60 H.P.	100	35,700	357.00
ROCHESTER TWP	21	62-B-541	1 pump @ 10 H.P.	10	5,600	560.00
SARNIA	22	60-B-159	3 Pumps @ 25 H.P. ea.	75	25,300	338.00
SAULT STE. MARIE	23	62-B-92	2 Cent. pumps 2-2 MGD @ 130' Head. 1 Diesel 1-4 MGD @ 140' Head	204	84,600	415.00
SIOUX LOOKOUT	24	63-B-704	Complete 2 pumps @ 200 GPM. 90' Head, manual control	20	9,050	452.00
THESSALON	25	63-B-501	3 Pumps @ 200 = 600 GPM @ 130 T.D.H. 1 Fire pump 1850 GPM @ 130' T.D.H.	129	59,000	458.00

TABLE 11 (CONT'D)

MUNICIPALITY	GRAPH NO.	DATE OF APPROVAL	DESCRIPTION	HORSE POWER	TOTAL COST IN DOLLARS (1965)	1965 DOLLARS PER HORSE POWER
TORONTO TWP	26	63-B-55	6 MGD - 400 H.P. Elect.; 10 MGD - 700 H.P. Elect.	1100	\$232,500	\$211.00
TORONTO TWP	27	57-B-14	2 Pumps elect. 1 Diesel standby	675	82,100	122.00
WHITBY	28	WW-64-16	1 - 100 GPM Pump 1 - 500 GPM Pump	27.5	16,610	605.00

TABLE 11-A

CONSTRUCTION COSTS FOR
WATER BOOSTER PUMPING STATIONSVARIABLES

X - Horsepower

Y - Construction Costs in dollars per horsepower

MODEL - $\log Y = a + b \log X$ EQUATION - $\log Y = 3.1576558 - 0.318448 \log X$ VALID RANGE OF X - 10 to 6300 H.P.CORRELATION COEFFICIENT - -.85STANDARD ERROR OF ESTIMATE - .154105RATIO FOR UPPER LIMIT - 1.4260RATIO FOR LOWER LIMIT - .7013VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
10	484.29	690.57	984.72
100	232.62	331.71	473.00
1000	111.74	159.34	227.20

TABLE 12
CONSTRUCTION COSTS FOR ELEVATED TANKS
 (Engineering & Contingencies Excluded)
 Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR APPROVED	TORONTO E.N.R. INDEX	CAPACITY (THOUSANDS OF GALLONS)	COST PER GALLON (CENTS)	1965 CENTS PER GALLON
AMHERSTBURG	1	1961	688	500	34	38.0
ANCASTER TWP	2	1959	642	750	31	37.2
BELLE RIVER	3	1955	543	250	22	31.0
BRAMPTON	4	1961	688	833	26	29.1
BRANTFORD TWP	5	1962	725	200	32	33.8
CHESTERVILLE	6	1959	642	125	34	40.8
COLLINGWOOD	7	1959	642	500	25	30.0
DEEP RIVER	8	1960	673	330	33	37.6
ESSEX	9	1957	596	250	35	45.1
FALCONBRIDGE TWP	10	1962	725	250	25	26.4
HAGERSVILLE	11	1959	642	167	29	34.8
HAMILTON	12	1958	607	1,250	29	36.5
HANOVER	13	1957	596	208	41	52.7
HARROW	14	1962	725	250	38	40.0
KINGSTON	15	1961	688	300	25	27.8
KINGSTON TWP	16	1961	688	300	24	26.6
KINGSVILLE	17	1962	725	250	34	36.0
LEAMINGTON	18	1958	607	333	34	42.8
MARKHAM TWP	19	1962	725	250	31	32.7
NASSAGAWEYA TWP	20	1963	732	125	36	37.6
NEELON & GARSON	21	1958	607	500	25	31.5
PEMBROKE	22	1957	596	500	34	44.0
PICKERING TWP	23	1959	642	250	40	48.0
RICHMOND HILL	24	1957	596	500	31	40.0
SIMCOE	25	1961	688	500	36	40.4
TORONTO TWP	26	1960	673	500	45	51.3
TORONTO TWP	27	1957	596	500	45	58.0
TORONTO TWP	28	1961	688	500	26	28.9
TORONTO TWP	29	1961	688	500	29	32.2
WELLINGTON	30	1962	725	125	36	38.0
WINCHESTER	31	1958	607	125	43	54.2

TABLE 12-A

CONSTRUCTION COSTS FOR
ELEVATED STORAGE TANKS

VARIABLES

X - Capacity in thousands of gallons

Y - Construction Costs in 1965 cents per gallon

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 1.7088257 - 0.054417 \log X$

VALID RANGE OF X - 125 to 1,250 thousand dollars

CORRELATION COEFFICIENT - -.15

STANDARD ERROR OF ESTIMATE - .092244

RATIO FOR UPPER LIMIT - 1.2366

RATIO FOR LOWER LIMIT - .8086

VALUE FOR PLOTTING

X	- Y -		
	Lower Limit	Expected Value	Upper Limit
200	31.00	38.34	47.41
400	29.85	36.92	45.65
1000	28.40	35.12	43.43

TABLE 13
CONSTRUCTION COSTS FOR STANDPIPES
 (Engineering & Contingencies Excluded)
 Toronto E.N.R. Index (1965) = 800

MUNICIPALITY	GRAPH NO.	YEAR APPROVED	TORONTO E.N.R. INDEX	CAPACITY (THOUSANDS OF GALLONS)	COST PER GALLON (CENTS)	1965 CENTS PER GALLON
BRACEBRIDGE	1	1958	607	250	11	13.9
BURK'S FALLS	2	1962	725	230	10	10.5
CAP ROUGE, QUEBEC	3	1957	596	200	12	15.5
COOKSTOWN	4	1962	725	200	14	14.8
DORCHESTER	5	1957	596	200	14	18.0
ELLIOT LAKE	6	1958	607	330	11	13.9
ESPAÑOLA	7	1961	688	200	12	13.5
E. GWILLIMBURY	8	1958	607	315	8.2	10.3
FRANKFORD	9	1958	607	117.5	16	20.2
HAVELOCK	10	1958	607	150	15	18.9
KING TWP. (OAKRIDGES)	11	1961	688	150	14	15.7
KING TWP. (SCHOMBERG)	12	1961	688	100	17	19.1
LAKEFIELD	13	1956	558	117.5	14	19.4
MARMORA	14	1960	673	425	6.8	7.75
NEWCASTLE	15	1960	673	150	19	21.7
SPECIAL (GABRIELLA)	16	1960	673	200	12	13.7
PORT PERRY	17	1961	688	300	8.7	9.76
PORT STANLEY	18	1963	732	182	9.2	9.6
ST. JACQUES, QUEBEC	19	1958	607	300	14	17.7

TABLE 13-A

CONSTRUCTION COSTS FOR STANDPIPES

VARIABLES

X - Capacity in thousands of gallons

Y - Construction costs in 1965 cents per gallon

MODEL - $\log Y = a + b \log X$

EQUATION - $\log Y = 2.4091376 - 0.542982 \log X$

VALID RANGE OF X - 100 to 425 thousand gallons

CORRELATION COEFFICIENT - -.72

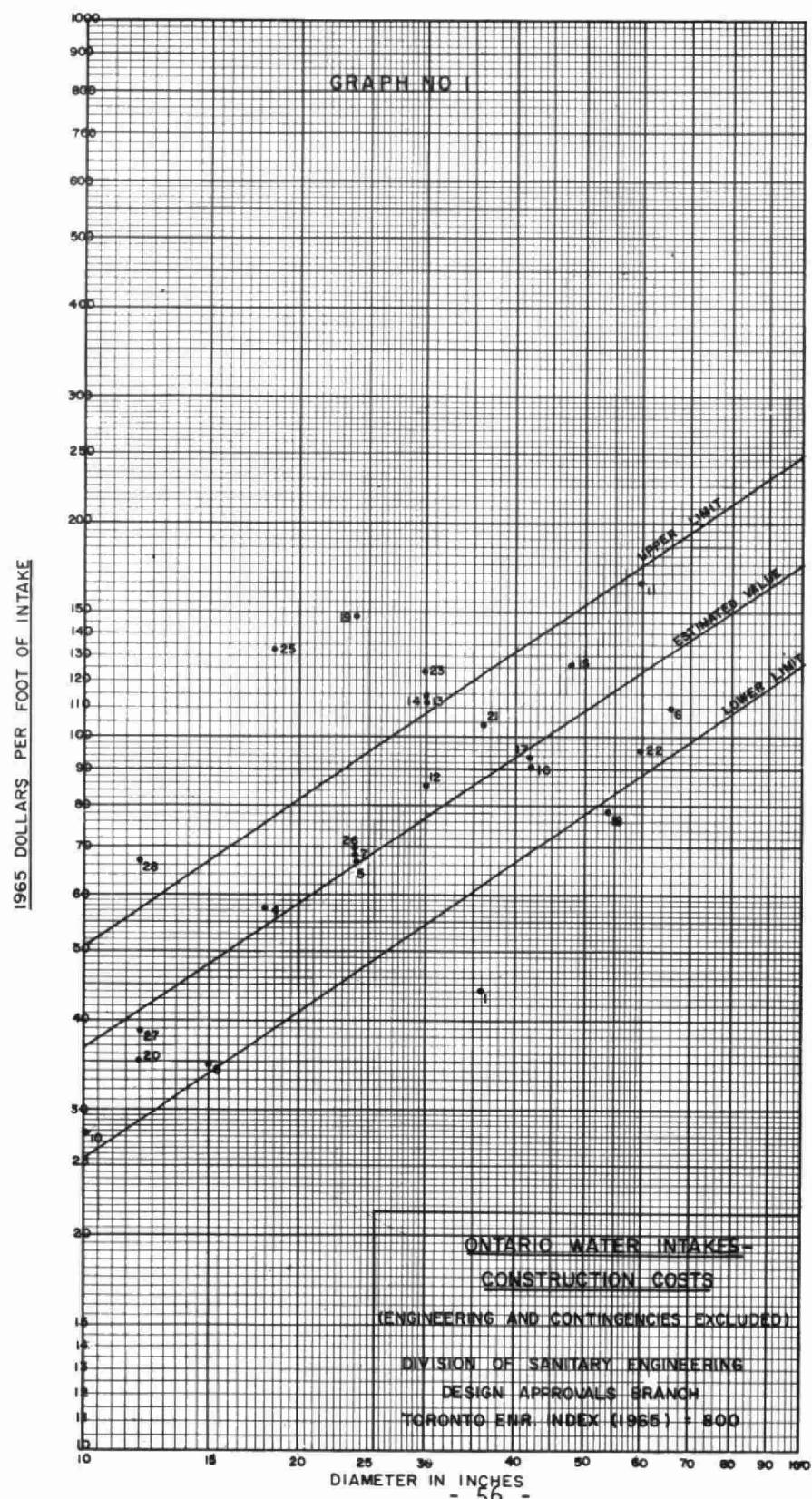
STANDARD ERROR OF ESTIMATE - .091123

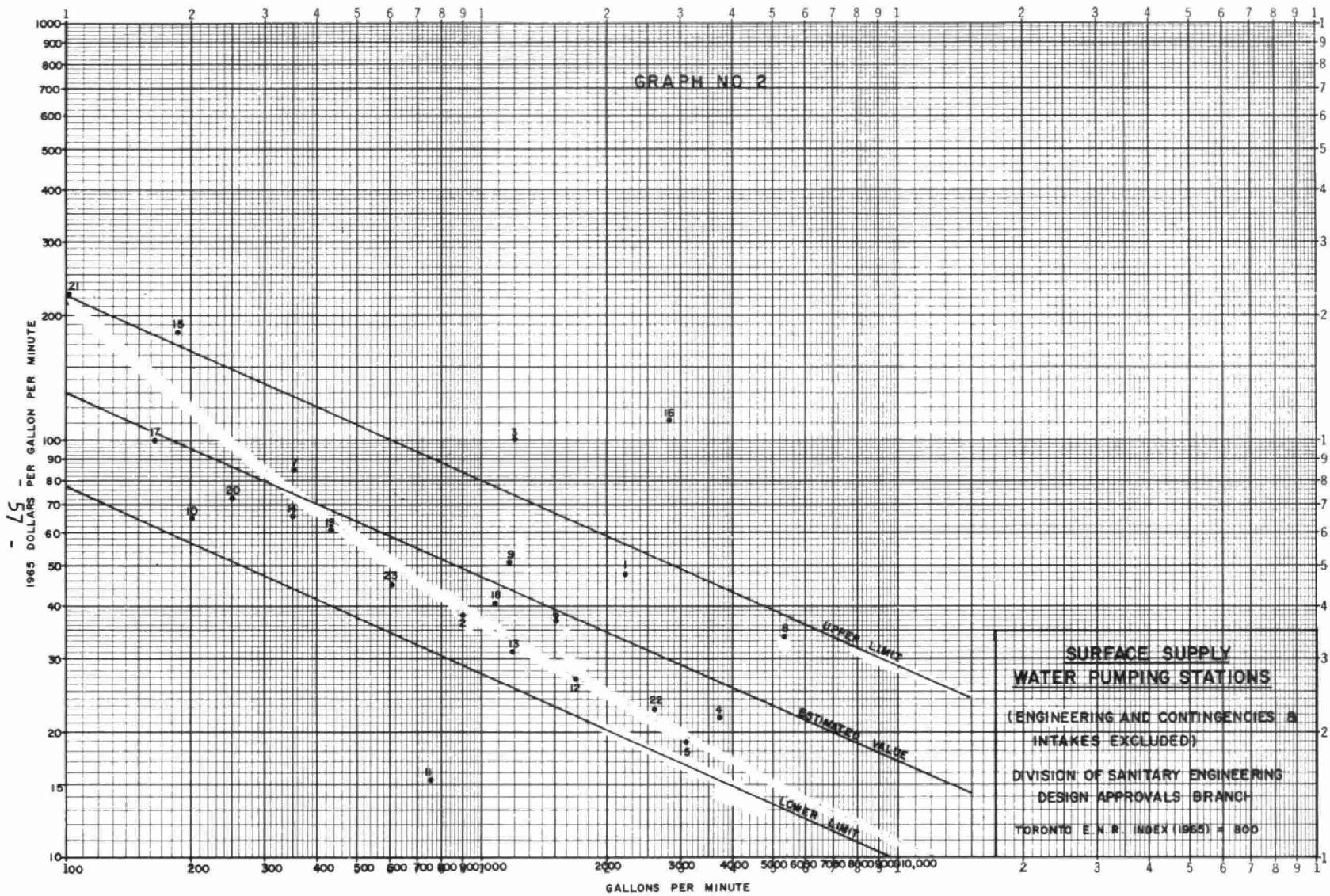
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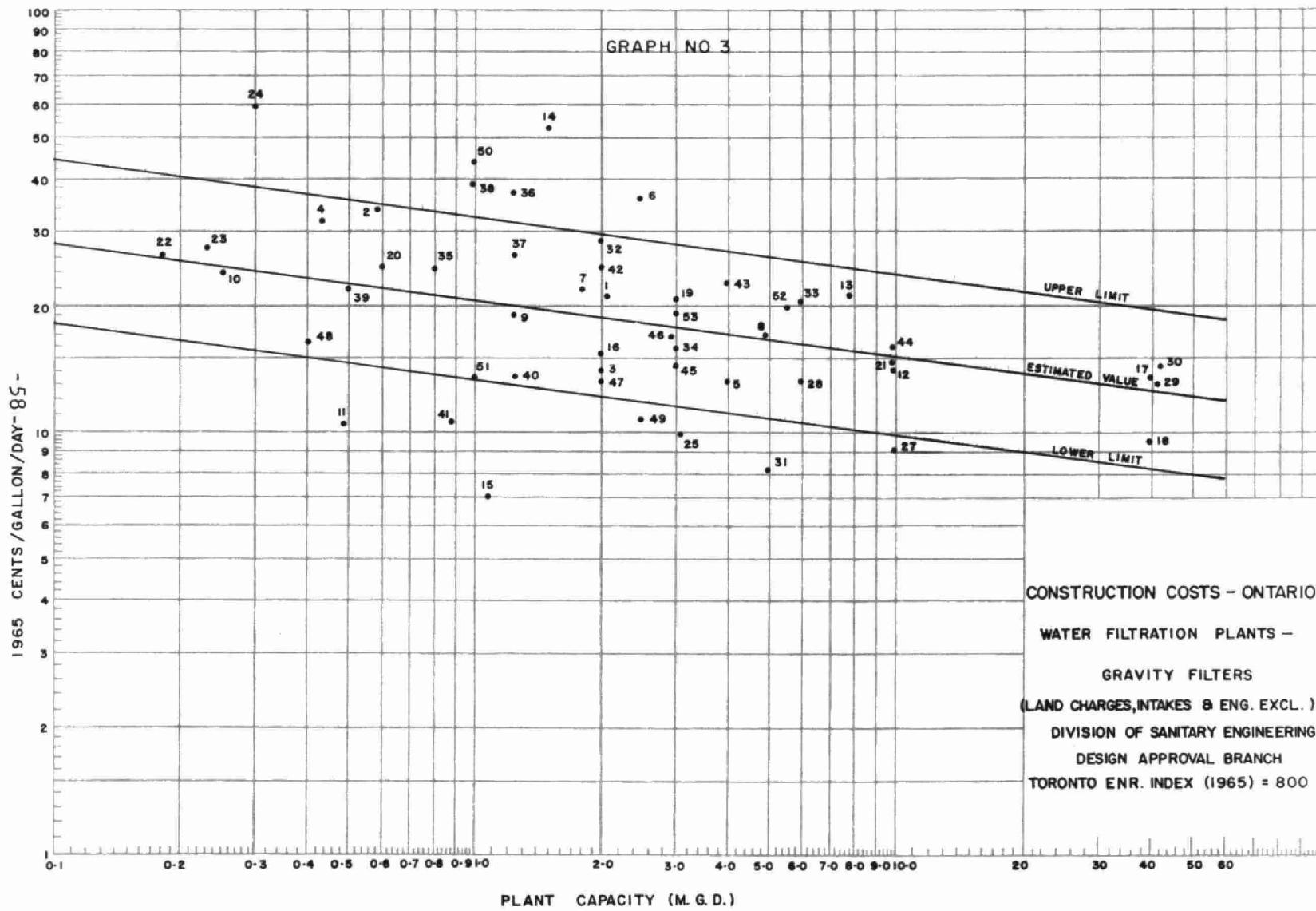
RATIO FOR LOWER LIMIT - .8107

VALUE FOR PLOTTING

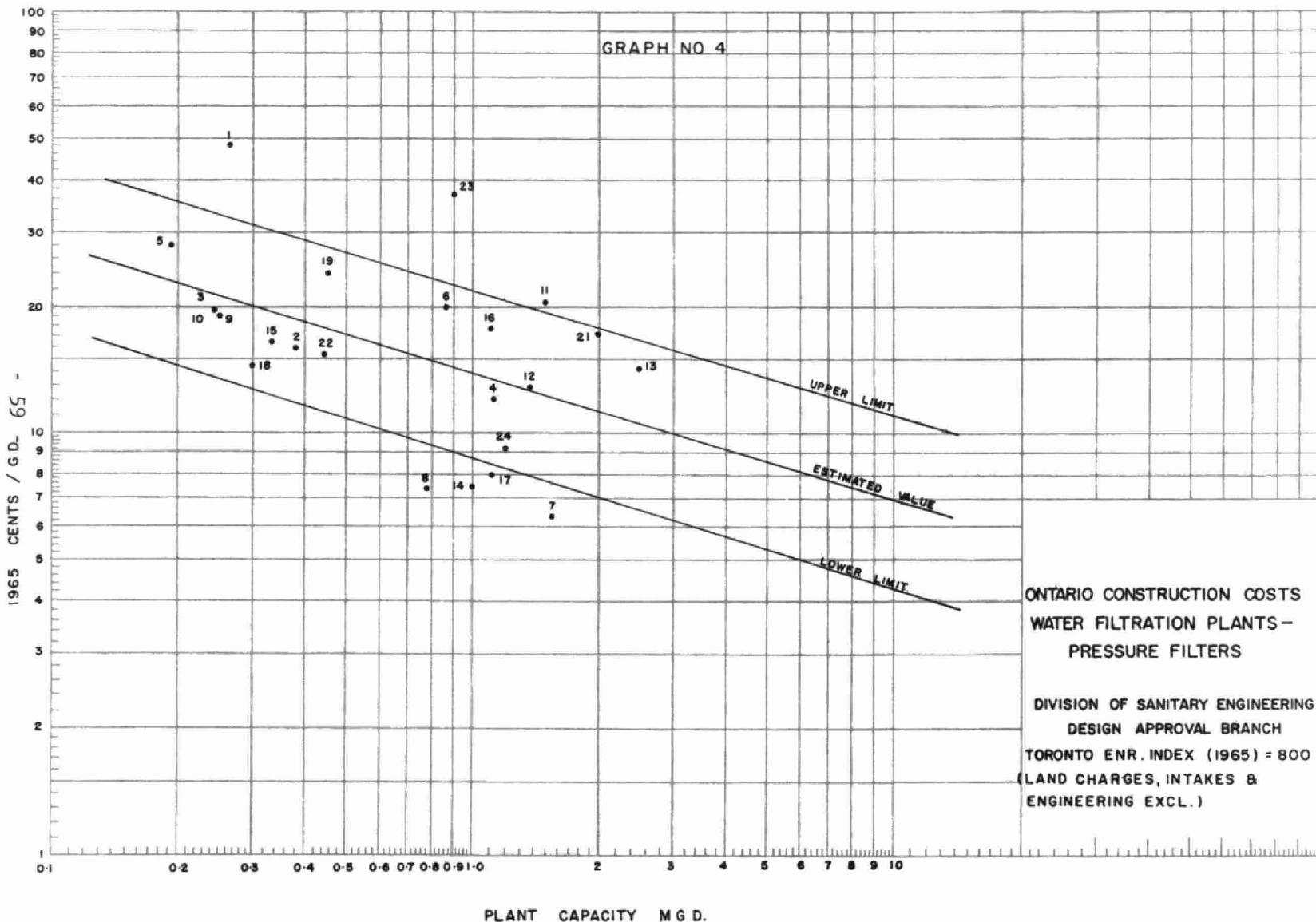
X	- Y -		
	Lower Limit	Expected Value	Upper Limit
100	17.07	21.05	25.97
200	11.71	14.45	17.82
400	8.03	9.91	12.22







GRAPH NO. 4



ONTARIO CONSTRUCTION COSTS
WATER FILTRATION PLANTS -

PRESSURE FILTERS

DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH

TORONTO ENR. INDEX (1965) = 800
(LAND CHARGES, INTAKES &
ENGINEERING EXCL.)

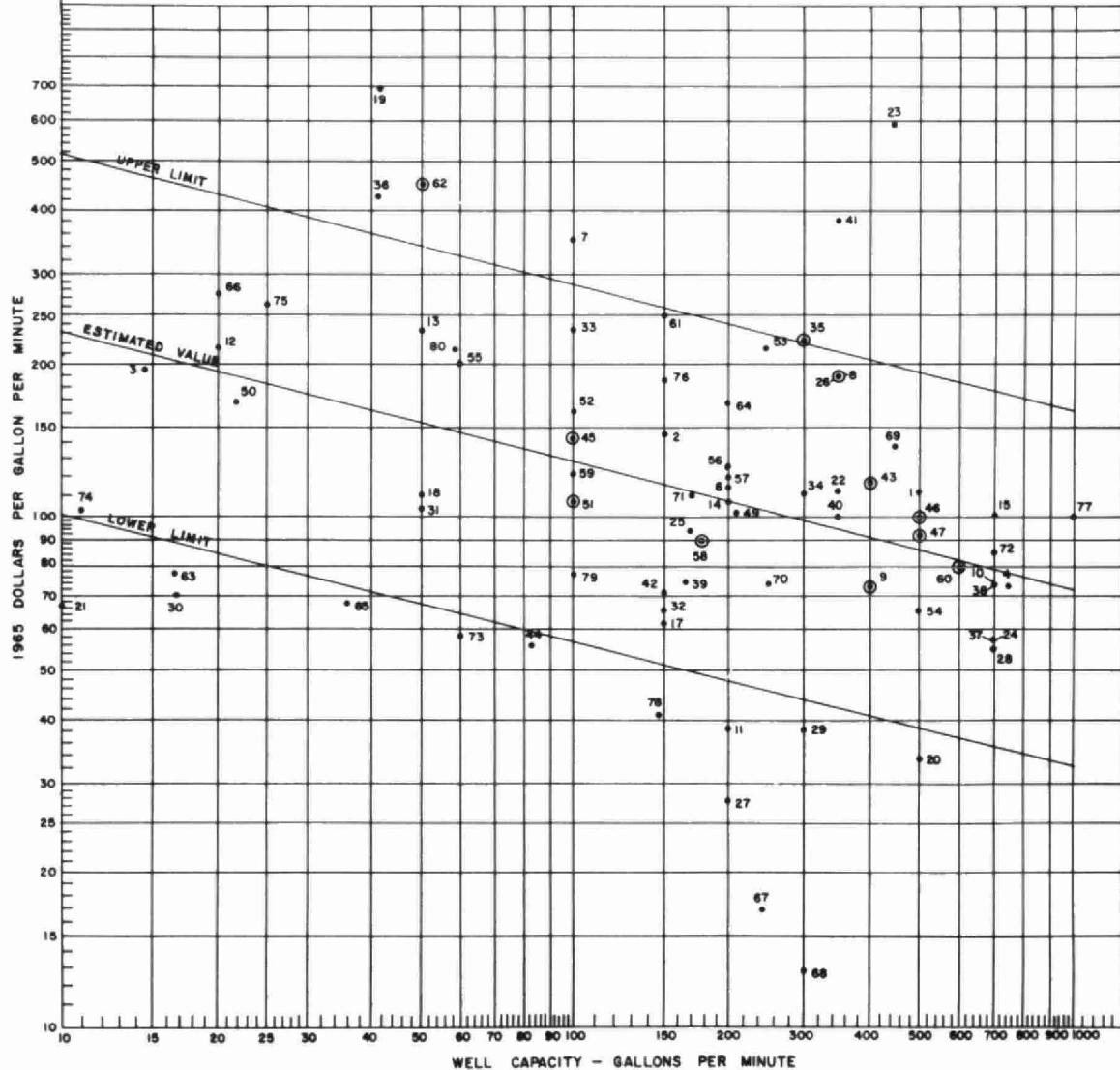
GRAPH NO 5

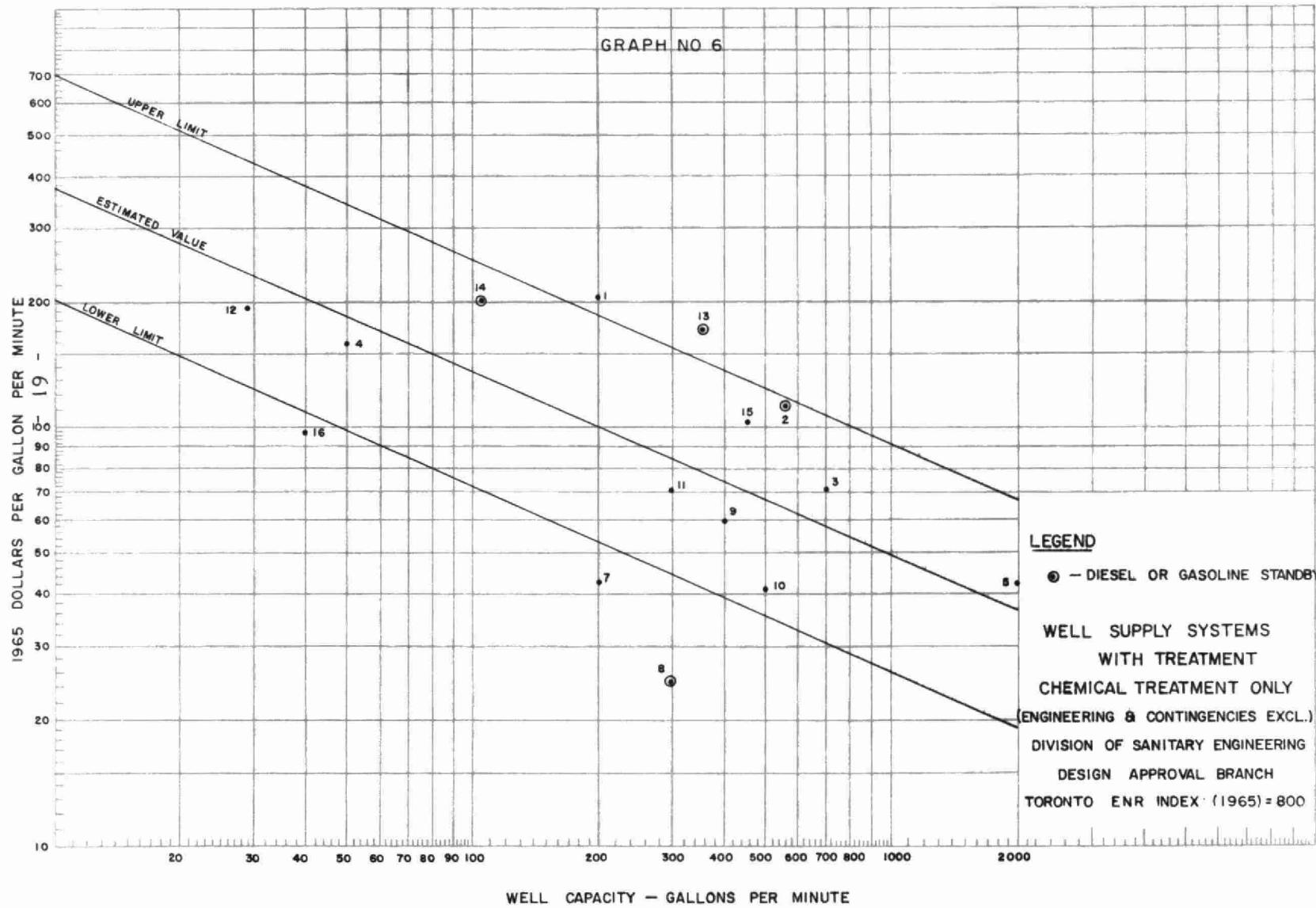
DIRECT PUMPING SINGLE WELL SUPPLY SYSTEMS WITHOUT TREATMENT

DIVISION OF SANITARY ENGINEERING - DESIGN APPROVAL BRANCH

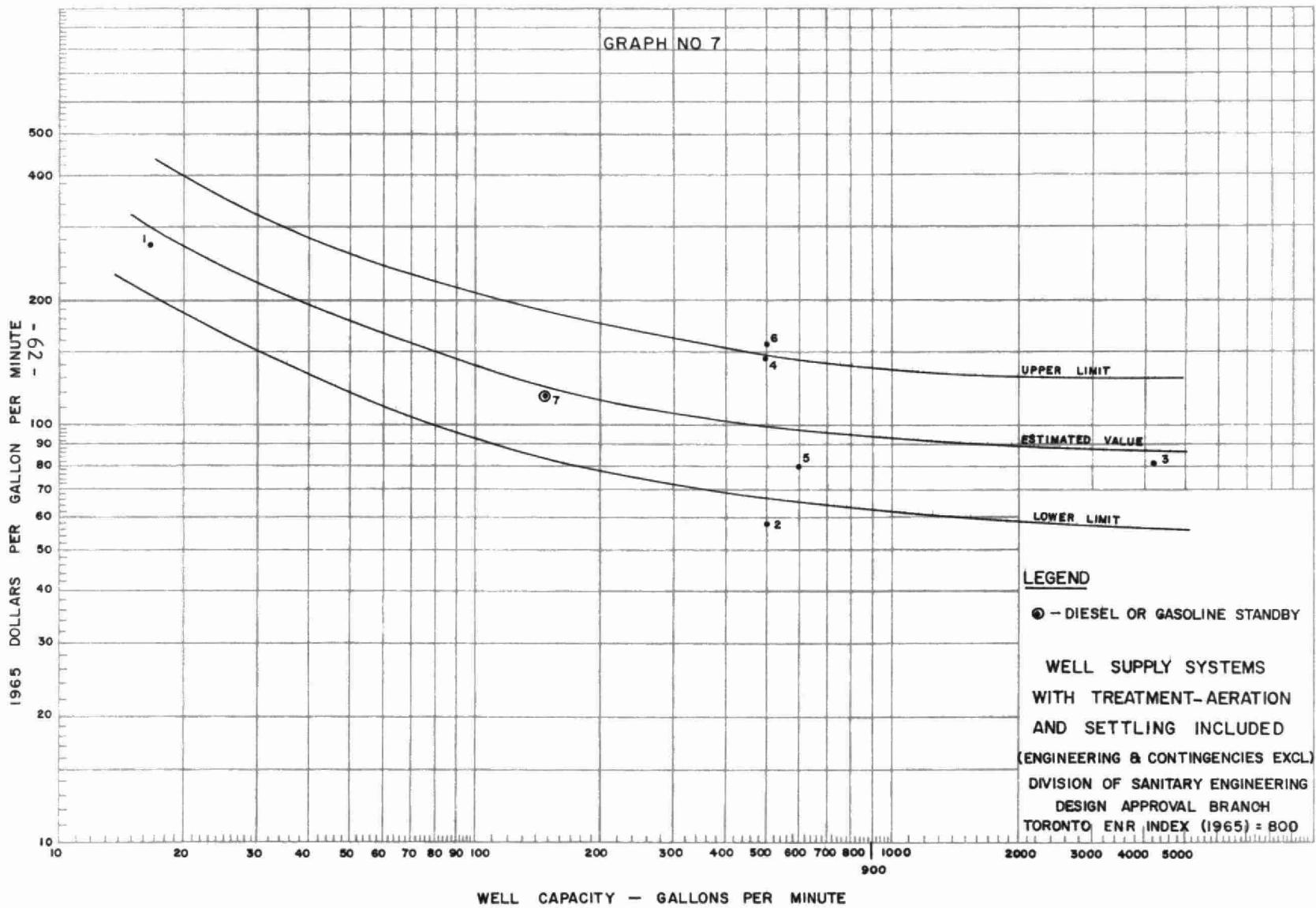
(ENGINEERING & CONTINGENCIES EXCLUDED)

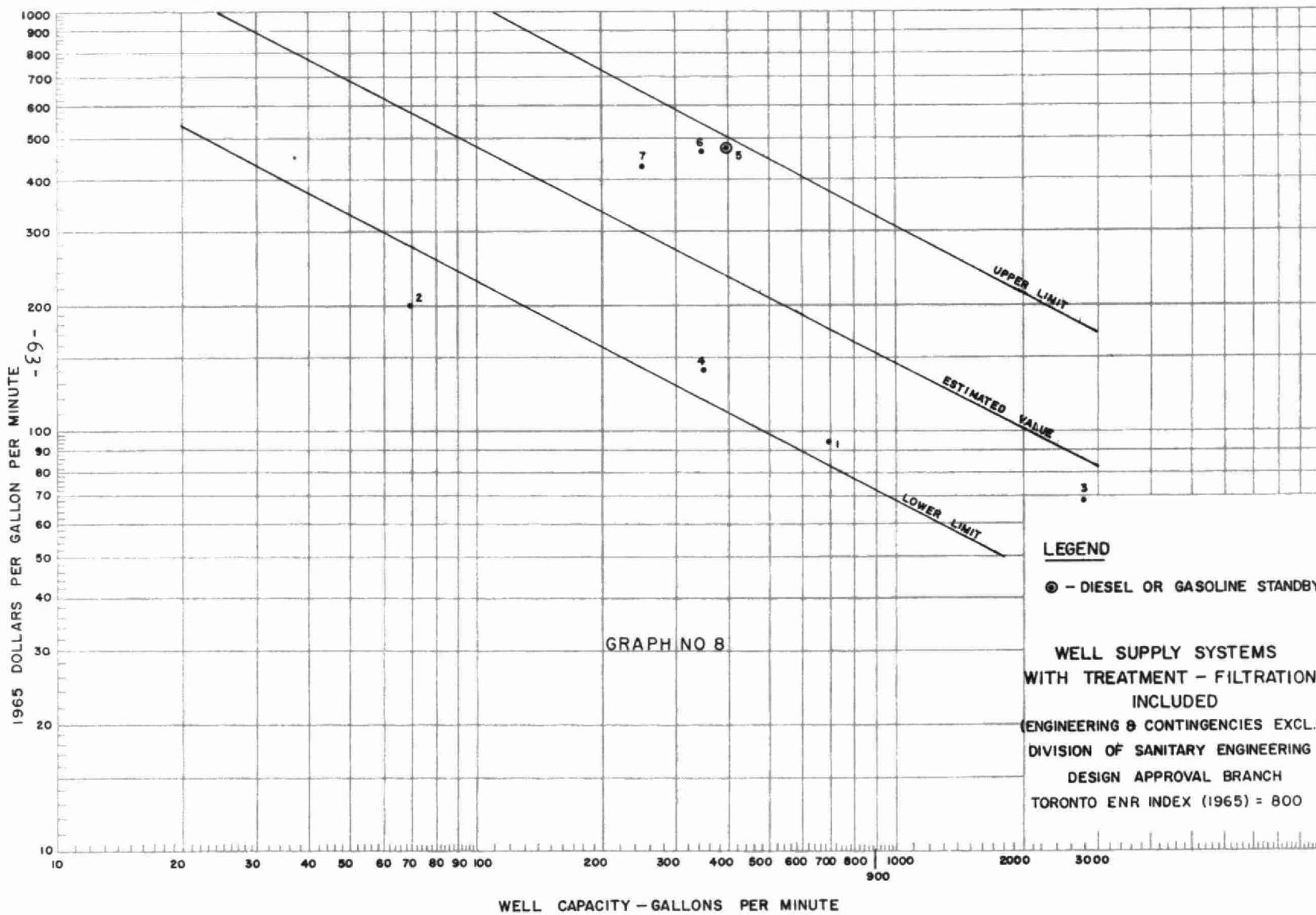
TORONTO ENR INDEX (1965) = 800

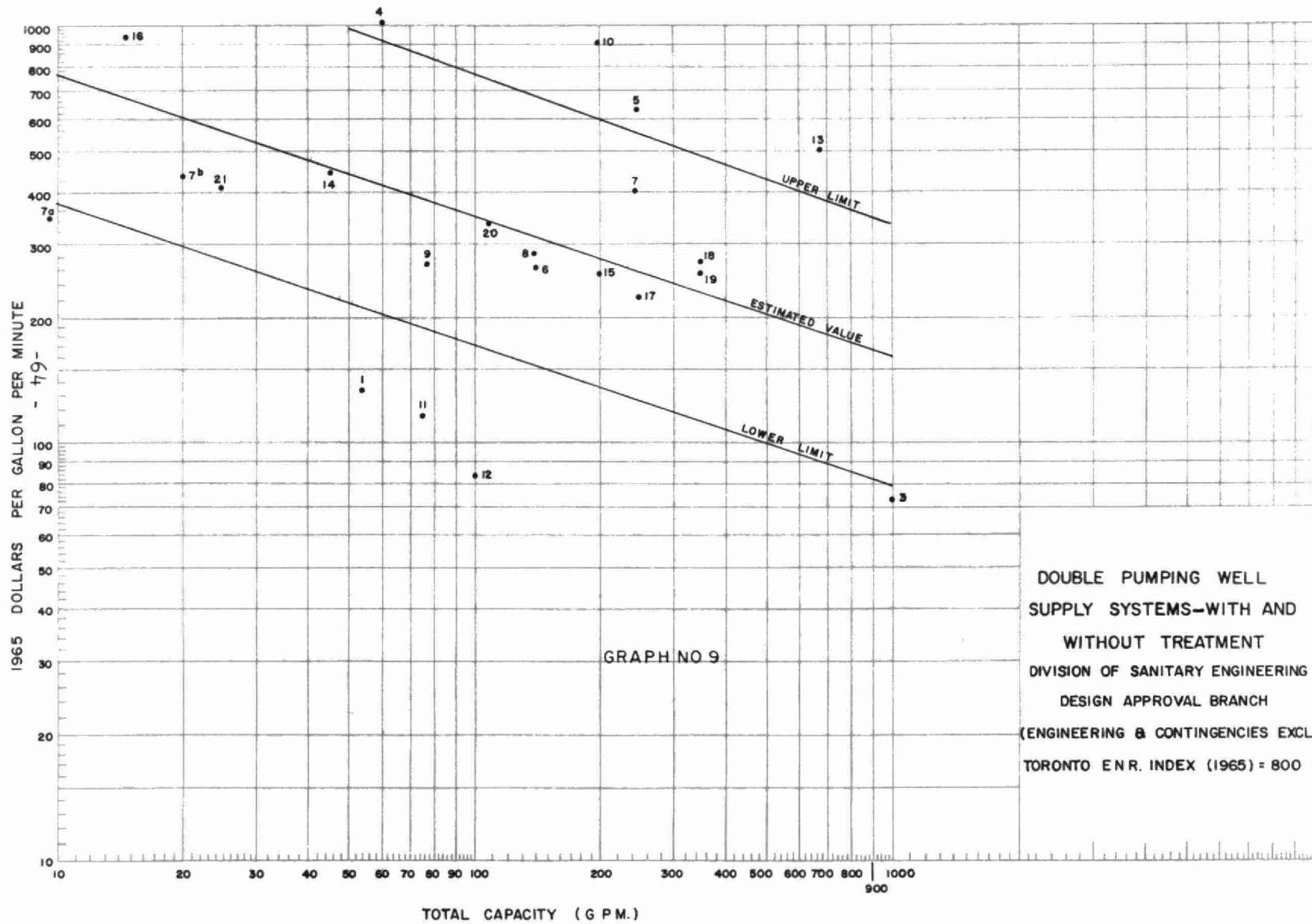




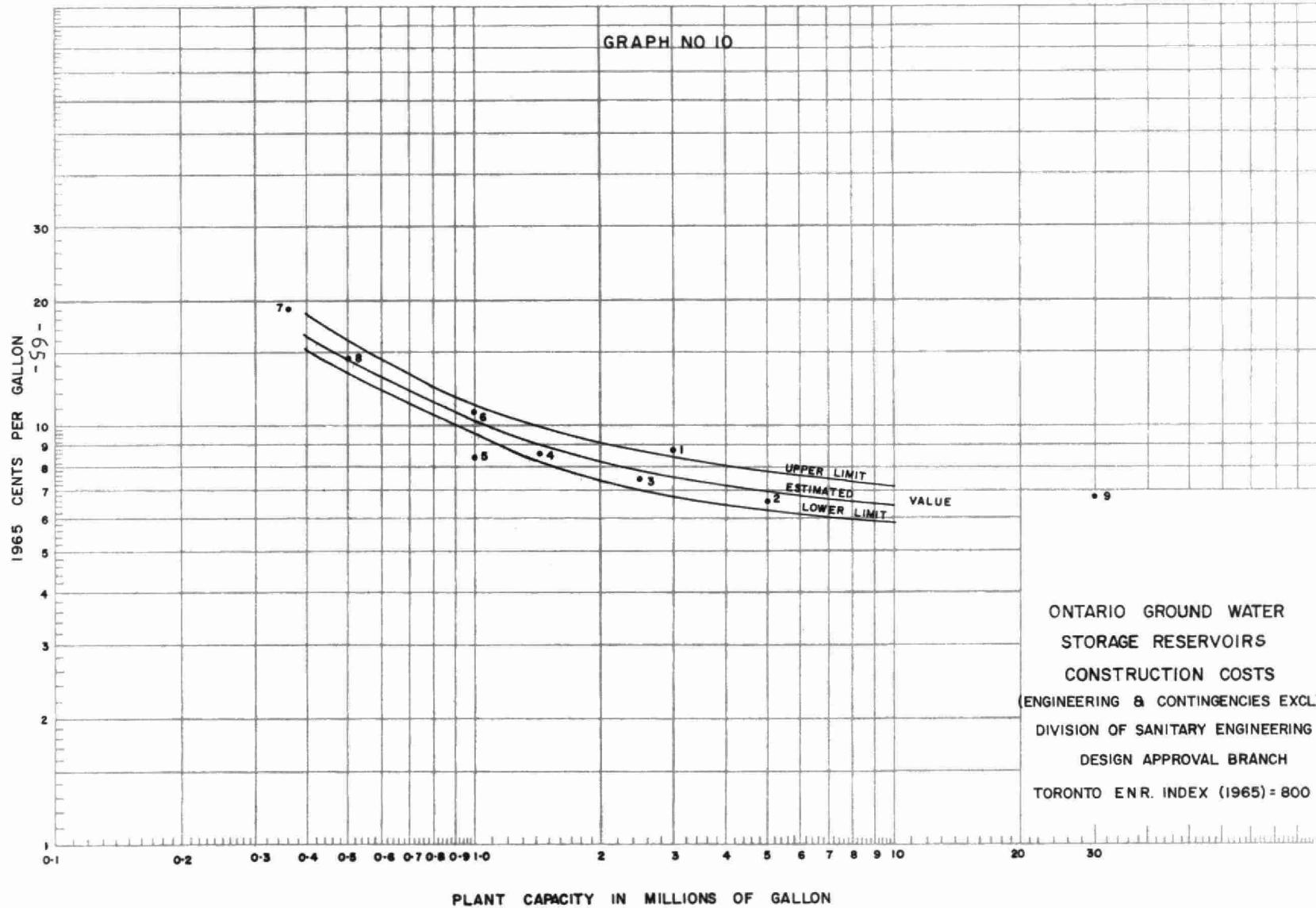
GRAPH NO 7







GRAPH NO 10



ONTARIO GROUND WATER
STORAGE RESERVOIRS
CONSTRUCTION COSTS
(ENGINEERING & CONTINGENCIES EXCL)
DIVISION OF SANITARY ENGINEERING
DESIGN APPROVAL BRANCH
TORONTO ENR. INDEX (1965) = 800

